B. Amendments of the Specification

Applicants have amended the specification by submitting a substitute specification under 37 C.F.R. § 1.121(b)(3). The substitute specification introduces no new matter. (A "Marked Up Version of Substitute Specification Pursuant to 37 C.F.R. § 1.121(b)(3)(iii)" is appended hereto at Tab 2.) Amendments of the specification are discussed below.

1. Addition of Section Headings, Amendment of Brief Description of Drawings

Applicants have added the heading "Background of the Invention" at page 1, immediately before the first paragraph, pursuant to 37 C.F.R. § 1.77(b)(5).

Applicants have added the heading "Summary of the Invention" at page 3, immediately before paragraph [0008], pursuant to 37 C.F.R. § 1.77(b)(6).

The specification included a brief description of FIGS. 1-3 at page 6, lines 18-27. Applicants have (1) amended the aforementioned brief description to better describe the FIGS.; (2) relocated the brief description to immediately follow paragraph [0008]; and (3) added the heading "Brief Description of the Drawings" immediately before the aforementioned description, pursuant to 37 C.F.R. § 1.77(b)(7).

Applicants have added the heading "Detailed Description of the Invention" at page 4, immediately before paragraph [0009] (and immediately after the newly added section entitled "Brief Description of the Drawings"), pursuant to 37 C.F.R. § 1.77(b)(8).

2. Replacement of references to claims

Applicants have replaced a reference to "the claims following claim 1" at page 6, lines 14-15 with language from claims 1-8 to conform the specification to U.S. patent prosecution practice. (See Marked Up Version of Substitute Specification, paragraph [0018].) MPEP § 608.01(l) ("In establishing a disclosure, applicant may rely not only on the description and drawings as filed but also on the original claims if their content justifies it.").

3. Description of FIG. 3

Applicants have amended the specification at page 9, paragraph [0024], to more clearly describe FIG. 3. (See Marked Up Version of Substitute Specification, paragraph [0026].) Support for this amendment is found in FIG. 3, the previous version of the paragraph, and throughout the previous version of the specification.

4. Clerical, Typographical, Idiomatic, and Grammatical Amendments

Applicants have added line numbering to the specification to facilitate the identification of text therein.

Applicants have amended the specification to correct minor typographical, idiomatic, and grammatical errors at the following locations:

Previous Version of Specification [illegible]	Marked-Up Version [illegible] Specification [illegible]
Page 1, line 13 (para. 2).	Page 1, line 18 (para. 2).
Page 1, line 16 (para. 2).	Page 2, line 2 (para. 2).
Page 1, line 19 (para. 3).	Page 2, line 5 (para. 3).
Page 2, lines 6-8 (para. 4).	Page 2, lines 11-13 (para. 4).
Page 2, lines 16-19 (para. 5).	Page 2, lines 22-25 (para. 5).
Page 2, lines 30-31 (para. 6).	Page 3, lines 5-6 (para. 6).
Page 3, lines 4-11 (para. 7).	Page 3, lines 13-23 (para. 7).
Page 3, line 14 (para. 7).	Page 3, line 27 (para. 7).
Page 3, lines 24-25 (para. 7).	Page 4, lines 4-5 (para. 7).
Page 4, line 12 (para. 10).	Page 5, line 10 (para. 14).
Page 4, line 25 (para. 11).	Page 5, line 23 (para. 15).

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[illegible]	[illegible]
Page 5, line 6 (para. 13).	Page 6, lines 4-5 (para. 17).
Page 5, line 13 (para. 13).	Page 6, line 11 (para. 17).
Page 5, line 16-20 (para. 14).	Page 6, line 14-20 (para. 18).
Page 5, line 24 (para. 15).	Page 6, line 24 (para. 19).
Page 6, line 6 (para. 15).	Page 7, line 5 (para. 19).
Page 6, lines 10-11 (para. 16).	Page 7, lines 10-11 (para. 20).
Page 6, line 28 (para. 18).	Page 8, line 22 (para. 23).
Page 7, lines 9-13 (para. 19).	Page 9, lines 3-8 (para. 24).
Page 8, line 3 (para. 21).	Page 9, line 30 (para. 26).
Page 8, lines 11-12 (para. 22).	Page 10, lines 5-6 (para. 27).
Page 8, line 14 (para. 22).	Page 10, lines 8-9 (para. 27).
Page 8, line 16 (para. 23).	Page 10, line 11 (para. 28).
Page 8, line 22 (para. 23).	Page 10, line 17 (para. 28).
Page 8, line 27 (para. 23).	Page 10, line 22 (para. 28).
Page 8, line 31 (para. 23).	Page 10, line 26 (para. 28).
Page 9, line 5 (para. 23).	Page 11, line 1 (para. 28).
Page 9, lines 22-23 (para. 25).	Page 11, lines 23-24 (para. 30).

[illegible]	[illegible]
Page 9, lines 27-28 (para. 25).	Page 11, lines 28-30 (para. 30).
Page 9, line 32 (para. 25).	Page 12, line 1 (para. 30).
Page 10, line 13 (para. 25).	Page 12, line 15 (para. 30).
Page 10, line 15 (para. 25).	Page 12, line 18 (para. 30).
Page 10, line 16 (para. 25).	Page 12, line 19 (para. 30).
Page 10, line 18 (para. 25).	Page 12, line 21 (para. 30).
Page 10, line 19 (para. 25).	Page 12, line 22 (para. 30).
Page 10, line 23 (para. 26).	Page 12, line 27 (para. 31).

C. Amendments of the Claims

Applicants have canceled claims 1-8 without prejudice and have added new claims 9-17 having subject matter that was present in the canceled claims. Applicants respectfully reserve the right to pursue the subject matter of canceled claims 1-8, including any embodiments originally defined by improper multiple dependent claims, in one or more continuation or divisional applications.

Claims 1-8 were replaced by claims 9-17 to remove improper multiple dependencies, select claimed

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embodiments for prosecution at this time, and to conform the claims to U.S. patent prosecution practice. Support for new claims 9-17 is found throughout the previous version of the specification, particularly at pages 3-11. Support for new claims 9-17 is also found in originally filed claims 1-8, as summarized in the following table.

[illegible]	[illegible]
9	1
10	1 and 2
11	1 and 3
12	1 and 4
13	1 and 5
14	1 and 5
15	1 and 6
16	1 and 7
17	1, 7, and 8

The new claims introduce no new matter.

D. Amendment of the Abstract

Applicants have amended the Abstract by submitting a replacement Abstract under 37 C.F.R. § 1.121(b)(2). The replacement Abstract introduces no new matter. (A "Marked-up Version of Replacement

Abstract Pursuant to 37 C.F.R § 1.121(b)(2)(iii)" is appended hereto at Tab 5.)

Applicants have deleted a clerical instruction, addressed to a foreign patent office, proposing the publication of a FIG. with the Abstract.

E. Conclusion

Applicants have amended the application to conform the specification and claims to U.S. patent prosecution practice and to select claimed embodiments for prosecution at this time. Also, applicants have made a clerical amendment of the Abstract.

Applicants respectfully request entry of the foregoing amendments. A favorable action is respectfully requested.

Respectfully submitted,

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I Hereby Certify that this Correspondence is being Deposited with the U.S. Postal Service as First Class Mail in an Envelope Addressed to: COMMISSIONER FOR PATENTS P.O. BOX 2327 ARLINGTON, VA 22202 on

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Lillian Garcia

Signature of Person Signing

MARKED UP VERSION OF SUBSTITUTE SPECIFICATION
PURSUANT TO 37 C.F.R.§ 1.121(b)(3)(iii)

VAW-7

METHOD FOR SETTING A PROCESS FOR THE MANUFACTURE OF SEALING SEAMS

BACKGROUND OF THE INVENTION

[0001] The invention relates to a method for setting a process for the manufacture of sealing seams, in which the interface temperature at the interface between the sealing partners is measured using a temperature-measuring element.

[0002] Sealing seams are used extensively to manufacture food packaging, e.g., for closing food packages. For example, a cover, e.g., made out of an aluminum-plastic laminate, paper-plastic laminate or plastic laminate, is used to seal the opening of milk product containers. So-called "stand-up-pouches" are also manufactured or closed by sealing the pouch

material. In addition, sealing seams are also used in other areas to bond so-called "sealing partners."

[0003] The sealing heat or sealing energy required to manufacture the sealing seam is introduced via the direct introduction of heat during so-called "hot sealing," ultrasound coupling or inductive coupling in the sealing area, for example.

[0004] During the manufacture of sealing seams, essentially three requirements must be satisfied. First, the machining time for manufacturing the sealing seam must be kept as short as possible. Second, the sealing seam must tightly [closes] close at the junction point. Finally, the sealing seam is to exhibit sufficient strength to withstand a load on the sealing partners, e.g., during the transport and storage of sealed containers; however, the bond must not be so strong as to prevent an intended opening without any excessive application of force.

[0005] A sealing seam that satisfies the above requirements is manufactured by setting the time-temperature-pressure progression in a suitable manner during pressing on the sealing tools. [Known to this end] To this end, it is known from the article [„]"Heat Sealing of Semicrystalline Polymer Films," [,] Journal of Applied Polymer Science, Vol. 51, 89-103 (1994) [is] to measure the interface temperature at the interface between the sealing partners by means of a temperature measuring element, e.g., a thermocouple, during heat input, to determine whether the melting temperature of at least one sealing layer of the sealing partners is exceeded during heat input. In addition, prior art describes a theoretical model that makes it possible to

calculate the interface temperature progression assisted by electronic data processing.

[0006] This known procedure for setting the time-temperature-pressure progression during sealing is problematic[al] as viewed from various standpoints. [On the one hand] For example, the described procedure can only be used to determine whether the melting temperature has been exceeded at the interface, while only very limited, if any, conclusions can be drawn about the extent to which the sealing layers were melted on.

[0007] In addition to the requirements described above [on] regarding the quality of the sealing seams, the [point in time at which the sealing seam has been cooled after heat input to the point where it can be loaded] amount of time needed after heat input to allow the sealing seam to cool sufficiently for the sealing seam to be loaded is also of great importance to the process for the manufacture of sealing seams. This is particularly important, [since] for example, so that cups into which milk products are placed [filled] can be loaded [immediate after sealed,] or subjected to a tightness check immediately after being sealed. During such a tightness check, the cup is usually subjected to pressure, and monitored to see whether the elevated pressure lifts the cover in the cup, i.e., whether the cup is tight. The load is [here] selected in such a way that the tightness check does not result in leakages or other damages to intact sealing seams, since the sealing layers might not have been completely hardened yet. On the other hand, production-related reasons dictate that the tightness check be conducted as soon as possible after heat input. To this end, prior art has only

described taking off the cover after heat input, and measuring the forces necessary to this end during cooling to solidification over the time and/or the removal length, in order to determine the [so-called „]hot-tack["] time, i.e., the time at which the sealing layers have solidified sufficiently to enable a nondestructive tightness check.

SUMMARY OF THE INVENTION

[0008] Proceeding from the prior art described above, the object of the present invention is to indicate a method for setting a process for the manufacture of sealing seams, with which the process parameters are set in such a way that the manufactured sealing seams easily satisfy all quality requirements and enable [a] better quality control.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1a is a diagrammatic view of the structure of sealing partners, before sealing, based on one embodiment;

[0010] FIG. 1b is a diagrammatic view of the structure of sealing partners, before sealing, based on another embodiment;

[0011] FIG. 2 is a time-temperature progression of the interface temperature for two embodiments of sealing bonds; and

[0012] FIG. 3 is a time-temperature progression of the interface temperature for another embodiment of a sealing bond and different sealing temperatures.

DETAILED DESCRIPTION OF THE INVENTION

[0013] According to the invention, the object derived and described above is solved by virtue of the fact that

the process is set based on the course of time of the interface temperature during and after heat input during the sealing. This invention is based on the knowledge that a synopsis of the course of time of the interface temperature during and after heat input can provide helpful clues for setting the process. This makes it possible to set the machining parameters in such a way as to ensure a time and cost-optimized manufacture and quality control of sealing seams.

[0014] Because the time-temperature-pressure progression during heat input is set according to the invention based on the course of time of the interface temperature during and after heat input in a first embodiment, an optimal quality of the hot-sealing seams can be ensured in as short a time as possible and at an optimized energy outlay taking into account the requirements mentioned at the outset.

[0015] As an alternative or in addition to the embodiment just described, the procedure according to the invention is further developed by setting the time for the tightness check and/or mechanical loadability after heat input. The possibility for exactly ascertaining the [so-called „]hot-tack["] time from the progression of the interface temperature before and after heat input makes it possible to fix the optimal time for a first mechanical load or for the execution of a nondestructive tightness check.

[0016] One of the basic preconditions for manufacturing a hot-sealing seam is ensured when setting the process by monitoring when the melting temperature of at least one sealing layer of the sealing partners is exceeded by the interface temperature during heat input.

[0017] A measure for the degree of sealing partner melting at the interface is obtained by determining the integral of the time-temperature progression of the interface temperature between the points [where the] at which the interface temperature exceeds the melting temperature and falls below the solidification temperature of at least one sealing layer of the sealing partners. The larger the integral, the more extensively the sealing layers of the sealing partners are melted on. Consequently, an evaluation of the integral makes it possible to set the pull-to-open force required to open the sealing seam, or determine a minimum strength over a minimum surface of the integral.

[0018] The [so-called „hot-tack" time after which a nondestructive tightness check is possible, for example,] hot-tack time can be determined [by virtue of the fact that] because the point in time at which the temperature of at least one sealing layer of the sealing partners falls below the melting temperature thereof [of at least one sealing layer of the sealing partners] is determined by the interface temperature.

[0019] In the majority of materials used for manufacturing a sealing layer, when the sealing layer cools down from a temperature [of] above the melting temperature to a temperature below the melting temperature, a recrystallization takes place, which in turn releases heat that becomes noticeable during the course of time of the interface temperature after heat input in a temporary reduction in the cooling rate. In another embodiment of the invention, if a recrystallization of at least one sealing layer is determined from a reduction in the cooling rate after heat input is complete, it can be determined from this

that the sealing layers have at least partially melted on, regardless of the temperature exceeding the melting temperature. The extent of the reduction in cooling rate or the delay in cooling provides information as to the extent the sealing layers have been melted on for sealing seams having crystalline [shares] portions.

[0020] The fact that recrystallization takes place after melting on of a sealing layer can be utilized by determining the recrystallization time and deriving information from this as to whether the [so-called „]hot-tack["] time has been reached.

[0021] There are numerous ways in which to design and further develop the procedure according to the invention. To this end, for example, reference is made to the [claims following claim 1,] following: The invention may include a method for setting a process for the manufacture of sealing seams, in which (a) the interface temperature at the interface between the sealing partners is measured using a temperature measuring element; and (b) the process is set based on the course of time of the interface temperature during and after heat input during the sealing. The invention may include one or more of the following features: (1) that a time-temperature-pressure progression during heat input is set; (2) that a time for a tightness check and/or mechanical loadability after heat input is set; (3) that the point at which the interface temperature exceeds the melting temperature of at least one sealing layer of a sealing partner is monitored during heat input; (4) that an integral of a time-temperature progression of the interface temperature is determined between the point at which the interface temperature exceeds the melting temperature of at least one sealing layer of the sealing partners and the point

at which the interface temperature falls below the solidification temperature of at least one sealing layer of the sealing partners; (5) that the time at which the interface temperature falls below the melting temperature of at least one sealing layer of the sealing partners is determined; (6) that recrystallization of at least one sealing layer can be determined from a reduction in a cooling rate after heat input is complete; and (7) that the recrystallization time is determined. [and also to]

[0022] Reference is also made to the description of [an] embodiments in conjunction with the drawings. [The drawing shows:

Fig. 1 a), b) A diagrammatic views of the structure of the sealing partners before sealing based on two embodiments;

Fig. 2 The time-temperature progression of the interface temperature for two embodiments of sealing bonds; and

Fig. 3 The time-temperature progression of the interface temperature for another embodiment of a sealing bond and different sealing temperatures.]

[0023] [Fig. 1a)] FIG. 1a presents a diagrammatic view of the structure of two sealing partners 1, 2 and the arrangement of a thermocouple 3 for measuring the interface temperature at the interface between the sealing partners 1, 2 during the sealing process. In the embodiment shown, the sealing partners 1, 2 have an identical structure. They each consist of an outer layer made of polyethylene-terephthalate (PET) 4, a middle layer 5 made of an aluminum material, and a sealing layer 6 made out of polyethylene (PE).

[0024] During the sealing process, the two sealing partners 1, 2 are pressed together by means of sealing tools (not shown). The sealing tools [having] have a temperature, T, and are pressed together with a pressure, [p] P, for a time, t, or based on a [T, P, t] T-P-t program with variable-time temperature and/or variable-time pressure. The temperature (T), pressure [p] (P), and time (t) or [a T, P, t] the T-P-t program can be set within prescribed limits depending on the respective sealing device.

[0025] In order to record the interface temperature progression necessary for realizing the invention, the thermocouple 3 is located between the polyethylene layers 6 of both sealing partners 1, 2 during the entire sealing process. After the measuring process, the thermocouple 3 is hence also sealed into the cooled sealing seam. As a consequence, the progression of the interface temperature can only be measured for a temperature-measuring element designed as a thermocouple 3 during one or numerous sealing processes executed outside the actual production process, but using the machines used for production on-site, and exclusively for purposes of recording these progressions. However, this is sufficient for obtaining the information required to improve the machining sequence. The other sealing machines used in regular production must only permit the introduction of thermocouples between the sealing tools, and allow the transfer of measuring results, e.g., via a trailing cable or telemetry.

[0026] [Fig. 1b)] FIG. 1b presents a second embodiment with two alternative sealing partners 7, 8, which exhibit a different layer structure. Sealing partner 7 consists of a layer of aluminum material 9, a polyethylene-

terephthalate (PET) layer 10 and a sealing varnish layer 11. The second sealing partner 8 is made completely of polypropylene (PP) 12 in the second embodiment.

[0027] The embodiment shown [on Fig. 1a)] in FIG. 1a shows the [constellation] configuration while sealing laminates, e.g., during the manufacture of stand-up-pouches, while the embodiment shown [on Fig. 1b)] in FIG. 1b shows the manufacture of a sealing seam for connecting a tear-off lid with a cup.

[0028] [Fig.] FIG. 2 presents a graph without markers to show the time-temperature curve of heat input over two sealing jaws, a graph with triangular markers to show the measuring points of the time-temperature progression for the interface temperature at the interface of an aluminum (30 μm)/hot-sealing varnish laminate as a first sealing partner[,] and polypropylene (PP) as the second sealing partner, and a graph with rhombic markers to show the measuring points of the time-temperature progression of the interface temperature at an interface between an aluminum/polyethylene-terephthalate/hot-sealing varnish laminate as the first sealing partner[,] and polypropylene (PP) as the second sealing partner. The time-temperature curve of heat input is preferably recorded at the inputs of the measuring equipment hooked up to the sealing machine. As is particularly evident in this depiction, the interface temperature progression must be measured during and after heat input during hot sealing to obtain complete information about the sealing process. In both cases, the highest interface temperature is only reached clearly after heat input is complete. In both cases, the integral of the time-temperature progression of the interface temperature

between the points at which the interface temperature exceeds the melting temperature and falls below the solidification temperature yields valuable data about the quality of the fabricated hot-sealing seam.

[0029] [Fig.] FIG. 3 [uses] shows graphs with square, triangular and rhombic markers to initially show the progression over time of heat input at three temperatures. Heat input took place in the three tests shown [on Fig.] in FIG. 3 over the course of 1.5 seconds at [a] jaw temperatures of 160°C (square markers), 140°C (triangular markers), and 130[ ]°C (rhombic markers). The [respective accompanying] corresponding time-temperature progressions of the interface temperatures [is also evident from] are shown in corresponding graphs, which have square, triangular and rhombic markers (indicating, respectively, jaw temperatures of 160°C, 140°C, and 130°C). All three measuring curves relate to the progression of the interface temperature at the interface between a polyethylene-terephthalate (12 μm)/aluminum (9 μm)/polyethylene-terephthalate (70 μm) laminate as the first and second sealing partner.

[0030] As is also evident from the measuring curves shown [on Fig.] in FIG. 3, the maximal interface temperature is only reached quite a long time after heat input is complete. Here as well, the integral of the time-temperature progression of the interface temperature between the point at which the interface temperature exceeds the melting temperature and the point at which the interface temperature falls below the solidification temperature provides useful information about the achieved sealing quality. Additional information can be obtained in the depicted measuring curves from the

flattening of the interface temperature cooling progression as the result of recrystallization, although this cannot be observed for each sealing material. Such a flattening cannot be observed in the measuring curve marked with rhombi owing to missing or insignificant recrystallization. It may here be assumed that the sealing layers have not been sufficiently melted on to establish a permanent sealing bond. By contrast, the measuring curve with triangles clearly reveals a flattening 13, so that extensive recrystallization, and hence good sealing seam quality, can be concluded. The measuring curve with squares only reveals a slightly elevated flattening 14, so that it may be concluded that the sealing seam quality cannot be significantly improved by a sealing jaw temperature increased to 160[ ]°C. However, a comparison of the latter two curves also shows that solidification at a sealing jaw temperature of 160[ ]°C takes place about two seconds later than at a sealing jaw temperature of 140[ ]°C, so that the anticipated optimal sealing jaw temperature lies in the 140[ ]°C range in this embodiment, since good sealing quality is here ensured, while the [„]hot-tack["] time is reached early.

[0031] The extent or time of recrystallization can be determined more precisely from the first or second differential function of measuring curves via the determination of [maximums] maxima or zero-crossings than from the depicted measuring curves as such. These first or second differential functions can be established with no outlay in EDP systems, which are routinely used to record such measuring curves.

[0032] For the sake of completeness, it must be mentioned that the measuring signal of the thermocouple

secured between the sealing partners on the interface is recorded by an analog/digital converter, and transformed into a digital signal, which is acquired by a measuring and evaluation program installed on a portable EDP system, for example. These types of systems constitute part of prior art.

MARKED UP VERSION OF REPLACEMENT ABSTRACT
PURSUANT TO 37 C.F.R.§ 1.121(b)(2)(iii)

VAW-7

ABSTRACT

[0033] The invention relates to a method for setting the process for the manufacture of sealing seams, in which the interface temperature at the interface between the sealing partners is measured using a temperature-measuring element. It was shown that setting the process based on the course of time of the interface temperature during and after heat input during the sealing makes it possible to optimize the machining parameters to achieve the best possible sealing seam quality, shortest possible machining time and lowest possible energy outlay.

[[0034] Fig. 3 is proposed for publication with the abstract.]